SCIENCE

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

BIOLOGY AND PREPAREDNESS[1]

THE association of ideas suggested by the words "biology" and "preparedness" probably marks the beginning of a new epoch in history. The careful consideration of the sequence of events that have led to the formal act of linking together these two words should supply material for an interesting chapter in history, and should furnish an impulse strong enough to reawaken in the minds of those who have already left hope behind them rational expectations for a slow but steady progress of civilization.

Science, as one of the chief witnesses to this fortunate union, is relieved of any necessity for explaining that while certain by-products may liberate destructive forces, her aims and methods tend beyond peradventure to conserve both life and energy. In view of the critical times in which we are living, this fact by itself is not even halfway satisfying. The human animal needs the stimulus of positive hope and the knowledge of actual accomplishment; and these will be added to our most treasured possessions when once we shall begin, after centuries of indifference, to make preparations for rational living.

During the last two years we have not only changed our general attitude towards life, but have been made most bitterly aware of the disappointments sure to follow dreams of incredible Utopias, or visions of universal peace. We have paid a high price for our failure to emphasize the greater importance of preparing to live ef-

[1] Read in symposium on "Biology and National Existence," meeting of the American Naturalists, New York, December 28, 1916.

fectively as compared with the special preparations we have thought essential for dying in proper fashion. Prophet, priest and mystic philosopher have urged men to prepare to die, while science has only recently directed attention to the larger duty of preparing to live more efficiently, happily and successfully. We are just beginning to realize that if *to-morrow we die, to-day* we must live.

The mental attitude necessary to appreciate the full significance of the present associations between the words "biology" and "preparedness" also calls for the formulation of a new philosophy of living —a philosophy that will be of more direct assistance in enabling us to face the present with a greater display of intelligence and courage than has hitherto been expended. This is not the time to make a mistake in the choice of the path we are to follow. If civilization is truly symbolized by the figure of a caravan crossing a desert, we can not permit any false prophet to act as our leader. Far better to endure patiently the dangers and trials of our present situation than to incur any additional risk.

In order to comprehend both the scope and spirit of the Preparedness Campaign the character of the forces that have shaped it must be given due consideration. A few of these are obvious, but many are not generally recognized. As a people the majority of us would not admit until forced by circumstances, the truth of the allegation that a vague though compelling sense of unrest and an ill-defined consciousness of lack of preparation for dealing with the critical situations in life, have created at this moment of world-wide crisis a desire both to reorganize our ways of living and to secure protection from invasion of our territory.

The campaign for preparedness, as we see it, has two distinct objects in view, representing double aspects of the same problem: personal and national preparedness. To discuss these two kinds of preparation as unrelated, is both impractical and illogical, because the personal can not be wholly separated from the national aspect. Personally we accept the reality of the presence of disease and face it, because most of us with our backs to the wall must do so. But in case of war, because there is time and opportunity for mystics living with their heads in the clouds to dream of a transformed humanity, some of us still believe that entirely unrelated problems are under discussion.

Preparations for war must be made because the sudden disappearance of its threatening specter could only be brought about by some miraculous metamorphosis in humanity; and the consideration of the probability of this should be left to those who assume the possession of prophetic ability. The extreme superficiality of any thinking that takes for granted the possibility of being able to recommend a method for the great and immediate reduction in the frequency of wars, is revealed in the mere supposition that the roar of guns and clatter of swords are the only sign of war. "When both are silent," said John Bigelow, "war may go on even more fiercely than ever before. Hate, vengeance, jealousy, covetousness, ambition, treachery, cowardice, survive." These conditions no magic touch can remove. When we remember these facts, and consider how few have been the efforts to analyze the genesis of impulses, to ferret out the causes of obsessions, to trace the origin of hatreds, or, to discover methods of controlling emotions without the formation of dangerous repressions, the boast that we can prevent war by the introduction of a change here and there in our social and political systems, has a very hollow sound. Before the outbreak of

the European war Israel Zangwill wrote to the late Mr. Stead:

> I take the opportunity of reminding Mr. Stead that more good will be done by facing the brutal facts of life and the European situation than by allowing the wish that war shall cease to be father to the thought that it is ceasing.

Indeed such a thought as Mr. Zangwill sought to oppose merely reflects the fanatic's contemptuous disregard for the necessity of keeping open the approaches to truth even when we ourselves have not the strength to do more.

The same spirit of weakness and disinclination to face life as it is is shown in the intellectualist's efforts to impress us with his ability to live in the world and not be of it. Those who recognize this particular form of complex can easily detect the signs of disappointed ambitions and dissociated personality rather than a lofty and commendable purpose.

A truly high purpose should culminate in a decision to go as straight as we can, without further temporizing, to the root of most of the troubles to which the flesh is heir, and to substitute for an astonishing amount of ignorance as accurate a store of knowledge as can be gathered together. In a reasonably short time the result of working with this object in view would so impress us with the magnitude of our task as to make us reject promptly all promises of salvation bearing the trade-mark of any "ism."

Concrete information of this kind would not only prevent the occurrence of many unpleasant surprises regarding some of the basic qualities of human nature, but would enable us to remove a good many of the causes that lead at critical moments to explosive reactions of great violence, disturbing alike to the development of a well-balanced personality, the cause of democracy, and the progress of civilization. Moreover, we know that if the forces giving shape to personality are not focused, dissociation is the result, with the subsequent development of peculiar mental qualities that possess high explosive potentiality. An excellent illustration of this is wishful thinking, which may become a habit; and when this occurs it forms a menace to orderly thought processes, and results in blocking the peaceful settlement of any questions either personal or national.

These are some of the conditions we fail to recognize because we have become so accustomed to measure the value of brain activity merely by the content of consciousness without considering the character of the processes concerned in the operation. The autocthonous thoughts that are the products of a split-up personality often supply an emotional spark to explode the powder, and on this account we should learn to recognize in the apparently harmless dreamer, to whose reveries we often give encouragement, a source of danger to the community not infrequently exceeding that of the victim of systemized delusions.

For similar reasons there are excellent grounds for not placing too much confidence in the intellectual judgments of any person who disregards logical conclusions and shirks the responsibility concerned in the reconciliation of faith and works; such a man tries first to ignore and then to obliterate every memory of defeat, and resorts to subterfuge to conceal the strong personal disinclination to meet definite issues by absorbing himself in some general scheme for the regeneration of humanity. In such cases it is often the half-repressed memories of a personal struggle ending in defeat that drives the loser to turn aside from the real world and its concrete problems to live in an imaginary one which can only be described in abstract or platitudinous phrases.

Although it would be superfluous to point out the important bearing the analysis of

some of our national traits would have in supplying the information essential for directing our energy to the best advantage, a reference may be made to one glaring example of specific ineptitude due to lack of emotional balance. Consider for a moment the extraordinary opportunity existing at this crisis in world affairs for our universities to make adequate provision for supplying the leaders of thought urgently needed if a triumphant democracy is to be assured. Is the contribution of these institutions to the intellectual awakening now in progress to be measured only by an amateurish interest in military preparedness? Have we not reason to expect, perhaps we may even say to demand, that our universities shall not base their chief claims for recognition as institutions of learning merely upon traditional and hereditary rights? Should they not now set the example of facing squarely the vital issues of the present? One proof that the gravity of the present situation has been appreciated might be found in some effort to break with the restrictive influences imposed by trying to satisfy the parochial notions of the alumni and by placing on governing boards and in administrative offices representative citizens competent to realize the value of scholarship and research and the importance of cultivating broad national ideals. The signs of the times are indeed threatening, but what can we expect in the way of great intellectual leadership from an institution that places so little value upon the influence of example as to retain the services of an athletic coach receiving more than double the recompense of any member of its faculty! Judged by their spirit and works, the universities have failed lamentably to rise to meet the present situation. To-day when we are so earnestly seeking the abolition of petty sectional feeling, and turn to our oldest institutions of learning for a substitute, we find only a Harvard, Yale or Princeton sentiment tending to prevent the development of the idea of service to the general government.

In undertaking to formulate concrete plans for a campaign of preparedness it is advisable to begin with the clear recognition of the collective, binding and directive forces supplied by the present biologic methods of studying human behavior. Upon the adoption of a biologic line of approach, not only apparently unrelated subjects are shown to be intimately dependent, but a still greater change is evident in the new mental attitude developed towards the actual significance of the history of the human race. It has generally been the custom to proceed from the discussion of relatively obscure events in the past to the analysis and interpretation of the behavior of persons now living. The almost exclusive use of this method has left us in profound ignorance of ourselves, and has delayed considerably the presentation of the underlying facts of history in a vital fashion. If we reverse the ordinary procedure and begin with the analysis of the phenomena of behavior by making a first-hand investigation of the processes as they actually take place in individual lives, we shall then be in a better position to advance historical interpretation by making the past live; an accomplishment impossible as long as the approach to the study of human life was along avenues lined by tombs where only records of the dead were visible.

When once the importance of interpreting life in terms of vital reactions is recognized, then we shall find it possible to proceed in a logical and enthusiastic manner to inaugurate a movement that promises to result in greater efficiency and success in living, and in this way an opportunity may be presented of demonstrating that democracy has the power to minister to the biologic needs of men. At present we have become so intoxicated with words that in

order to evade facing a good many pretty stern facts, we are almost ready to accept as efficient any public confession of faith in crude notions about political freedom. We really dread discussing biologic problems.

But what indications are there that we are on the right path of biologic discussion? The efforts to remedy the present neglect of the study of the brain and nervous system are few, because the interest of the general public has not been aroused to the necessity for it. It is a most curious comment upon the lack of interest shown in our universities and institutions devoted to research, that so little attention is paid to making any adequate provisions for increasing our knowledge of these organs—the brain and nervous system—which are commonly esteemed to be the chief stock in trade of institutions of learning. While encouragement is given to those who delight to speculate upon man's place in nature, practically little has been done to assist in the determination of those structural and functional differences of the nervous system that are responsible for our elevation above the plane occupied by our simian ancestors. The time is rapidly passing, as Yerkes has pointed out, when on account of the disappearance of the higher apes it will be possible to trace the various gradations in our ancestral line. Of equal importance to these problems should be the studies made upon the nervous system with the object of correlating the structural and functional changes taking place during the early stages of the life of the individual. With the methods now at our command this particular field of investigation should offer fruitful results to the student. By carrying out these comparative studies a great deal of valuable information could be obtained which would throw light upon the fundamental nature of the adjusting processes and indicate the order followed as the capacity for adaptation was extended.

Think of the extraordinary opportunities existing in New York—the greatest melting-pot the world has ever seen—for the analysis of human behavior! Parents, educators, social workers, physicians, anthropologists, criminologists, eugenists, those endeavoring to find improved methods for increasing industrial efficiency, lawmakers, and all persons interested in the acquisition of knowledge relating to the regulation of human behavior, need to feel the inspiration coming from the realization of working towards a common goal.[2]

It would not be difficult to plan some central organization aiming to coordinate effort and to correlate results in attacking problems that are of the most vital importance for our personal and racial salvation. If we continue merely to dabble the tragic results will be even more appalling than they are to-day. Let us not deceive ourselves any longer nor try to apologize for our failure to understand and direct intelligently human energy by referring as "evidences of organized charity" to the application of remedies to correct the end stages of imperfect adjustment in numberless people.

In addition to a coordinating center of activities there is urgent need in New York for a great university psychiatric clinic dedicated to the investigation of the countless forms of imperfect adjustment generally described as mental disease. To those of us who are familiar with the methods used by the modern alienists to analyze the personality and to trace the genesis of these disorders, it is obvious that their knowledge is absolutely essential for the reorganization of our entire educational system. By the promptness with which

[2] Sums expended annually by the City of New York in directing human energy:

Education	$47,000,000
Protection of life and property	59,000,000
Charities	12,000,000

these objects shall be obtained we may easily estimate both our national intelligence and our peace-loving qualities.

Must it be the grim necessity of war only that shall awaken us to a nation-wide mobilization of all human forces for a single great purpose? Have we the mental capacity to be led by reason rather than driven by necessity "to sacrifice comforts, indulgences, and elegancies" for the purpose of acquiring the knowledge of self without which a practical preparation for living is impossible?

Stewart Paton

Princeton, N. J.

THE ECOLOGICAL SIGNIFICANCE OF SOIL AERATION

During the past two years the writers have conducted, independently, laboratory investigations into the relation of plant roots to the composition of the soil atmosphere and especially to deficiency of oxygen or excess of carbon dioxide in this atmosphere. These investigations are still in progress and will be reported later. It seems, however, that certain features of the results already obtained have important ecological significance, and this phase of the matter is presented in the present preliminary paper.

One series of experiments was conducted by one of us (Cannon) in the Desert Laboratory of the Carnegie Institution of Washington at Tucson, Arizona, and in the Coastal Laboratory of the same institution at Carmel, California. Seedlings of *Prosopis velutina,* and cuttings of *Opuntia versicolor* were grown in glass tubes filled with sand and connected with a gas reservoir in such a manner that any desired gas or mixture of gases could be caused to replace the ordinary atmosphere of the tubes at will. Each tube was sealed with wax and usually a water seal was used in addition. By the use of appropriate thermostats the tubes were kept at any desired temperature. In all cases the shoots were exposed to the atmospheric conditions of the laboratory. The growth of individual roots was observed directly by means of a horizontal microscope. The experiments included tests with pure carbon dioxide and various mixtures of this gas with atmospheric air or with oxygen.

As a leading result it was learned that the roots of *Prosopis* and of *Opuntia* have unlike responses to carbon dioxide. Exposure to pure carbon dioxide causes cessation of growth in the roots of both species. However, the recovery on the admission of air is uniformly more rapid with *Prosopis* than with *Opuntia.* The two species respond differently, also, to percentages of carbon dioxide which are high but below 100 per cent. Thus mixtures of 50–75 per cent. carbon dioxide with 25–50 per cent. oxygen, do not stop root growth of *Prosopis,* but do stop that of *Opuntia.* Apparently excessive amounts of carbon dioxide in the soil atmosphere would act as a limiting factor for the latter plant, even if the oxygen content of the soil atmosphere was normal or above normal. Neither excess of carbon dioxide nor diminished supply of oxygen inhibits the growth of *Prosopis* roots, for growth did not wholly cease when an atmosphere containing less than 2 per cent. of oxygen was employed. However, entire deprivation of oxygen appears to inhibit growth since the roots did not grow in pure carbon dioxide. Thus while the effects of the undiluted carbon dioxide on root growth of the two species is apparently the same, namely, the cessation of growth, the responses leading to this effect may be quite different.

The conclusion that the root response to a variable ratio of oxygen to carbon dioxide in the soil atmosphere is a specific response, is supported further by the results of direct aeration experiments on several species of plants, among which were *Opuntia, Prosopis, Fouquieria splendens,* and garden varieties of cucumber and watermelon. An increased air supply to the roots of *Opuntia* and *Fouquieria,* if not excessive, favors root branching and probably accelerates the rate of root growth. In the case of *Prosopis,* increased aeration of the soil appeared not to affect the growth rate of the roots. The results with cucumber and watermelon were not consistent, although in the latter case the shoot growth appeared to be

more vigorous when the soil containing the roots was artificially aerated.

The other series of experiments was conducted by one of us (Free) under the direction of Professor B. E. Livingston in the laboratory of plant physiology of Johns Hopkins University. A technique has been devised by which plants of mature size can be sealed into tin cans of about two liters capacity, the shoot projecting through the seal into the open atmosphere. The root system, with the soil in which it grows, is inside the sealed space and the soil atmosphere can be replaced at will by an atmosphere of any desired composition. Water is supplied to the plant by the Livingston auto-irrigator. The controlled atmosphere inside the can is kept automatically at a pressure slightly (about 3 centimeters of water) greater than the general atmospheric pressure, changes of volume due to variable temperatures being compensated. This assures that any slight leakage will be outward and without effect on the experiment.

With this technique experiments have been made on four species: *Coleus blumei, Heliotropium peruvianum, Nerium oleander* and *Salix* sp. (probably *nigra*). With *Coleus* it is found that even a very small decrease of oxygen below that normal to the atmosphere is injurious to the plant. Thus a plant, the roots of which were supplied with gas consisting of 75 per cent. air and 25 per cent. nitrogen, was injured within three days and killed within 45 days. With lower oxygen content in the soil atmosphere injury and death are still more prompt. *Heliotropium* behaves substantially like *Coleus,* except that the period between initial injury and death is shorter. Nerium is much more resistant to oxygen deprivation. With a soil atmosphere of pure nitrogen, injury was first apparent in the shoot after 26 days. An atmosphere of 50 per cent. air and 50 per cent. nitrogen had produced no perceptible injury in 45 days when the experiment was stopped. Dilution of the soil atmosphere with carbon dioxide instead of nitrogen appeared to have a like effect. No evidence was observed of any specific toxic effect of carbon dioxide, though such an effect is not excluded by the experimental results.

The most interesting result was with *Salix.* With this plant entire deprivation of oxygen appeared to be without injurious effect. In an experiment three times repeated the plant grew normally with a soil atmosphere of pure nitrogen, one of the experiments lasting for ten weeks. Replacement of the nitrogen with carbon dioxide and the use of various mixtures of carbon dioxide and air were also without perceptible effect. It appears that this species of *Salix* is quite independent of the content of oxygen in the soil atmosphere. That the respiration of the root cells can be anaerobic is less certain, but is strongly suggested by the data.

The two series of experiments outlined are sufficient to show that different species of plants may differ markedly in their response to variations in the composition of the soil atmosphere, and hence to changes in soil aeration. The effects of diminution of oxygen are manifest and the results with *Opuntia* indicate a direct and specific effect of carbon dioxide in addition to the effect of the dilution of the oxygen.

Though many details are lacking it is known that the composition of the soil atmosphere is neither the same as, nor so constant as, the composition of the general atmosphere. The presence of living matter in the soil, including bacteria, fungi and protozoa, as well as the roots of higher plants, tends to decrease the oxygen of the soil atmosphere and to increase its content of carbon dioxide. Doubtless there are chemical reactions associated with the decay of dead organic matter and which have the same or similar results. This tendency toward impoverishment in oxygen and enrichment in carbon dioxide must be counteracted by diffusion between the soil atmosphere and the general atmosphere, assisted, no doubt, by changes in barometric pressure and in temperature of soil and air. The importance of these assisting agencies is difficult to estimate but the effect of diffusion alone has been shown by Buckingham[1] to be extremely slow. Doubt-

[1] Bulletin 25, U. S. Bureau of Soils (1904).

less in normal cases the soil atmosphere is always slightly higher in carbon dioxide and slightly lower in oxygen than is the general atmosphere. Since the diffusion processes are effected very markedly by the average size of the interspaces between the soil particles, the difference in composition between the soil atmosphere and the general atmosphere will be greatest in the soils of fine texture and least in those of coarse texture. The similar effect of the soil water is obvious, especially the effect of the water existing as films about the grains in diminishing the size of the spaces available for gas diffusion.

The ecological bearing of these facts is manifest. Although deficiency in aeration has frequently been suggested as an agricultural difficulty, or as the reason why certain species do not grow upon soils of heavy texture, it does not appear that this suggestion has had any exact experimental basis, nor does it seem to have been appreciated that different species may have great differences in the oxygen requirement of their roots and widely variant responses to differences in soil aeration, responses which appear to be quite as specific and significant as the responses to temperature and to available water which form the present basis of ecological classification. The importance of root-habits in ecology has long been recognized on the basis of their characteristic and specific reaction to the features of the soil environment included under temperature and water relations. Thus it has been shown that the general distribution of the cacti as a family is closely related to the response of the roots to the temperature of the soil. It seems probable that soil aeration must be added as a factor of no less importance than temperature and water. Thus in the matter of local distribution of cacti, it is probable that the restriction of this family to habitats which have a relatively well-drained soil, in which the accumulation of carbon dioxide during the season of most active root growth is probably relatively slight, may be owing in part to the inability of the roots of these forms to grow well in an atmosphere charged heavily with carbon dioxide. On the other hand, the distribution of *Prosopis* and *Nerium* along the river bottoms, and of *Salix* in swamps, indicates that the presence of a relatively large amount of carbon dioxide in the soil does not act as a limiting factor to these species. Again, Howard[2] notes that the general distribution of the gram (chick-pea) as a crop in India is closely associated with the fact that the roots of this species require a relatively large amount of air. It accordingly occurs only, or mainly, where the soil and the system of cultivation provide an amount of air sufficient for its root growth.

In many semi-arid regions the physiography is such that there are relatively large and shallow basins without outlet, the central portions of which are flooded during rainy seasons but are dry for most of the year. Usually the central flats or playas of such basins have soils composed largely of fine silt or clay, and which puddle easily. It is characteristic of these playas that they are void of plant life during all, or most, of the year, and that no perennials are to be found in the lowest places, even when no excess accumulation of salts in the soil has occurred. It is here suggested that the probable reason for the absence of plant life on such playas is directly traceable to insufficient soil aeration at the time when the soil is suitably moist and of a temperature suitable for the growth of plants. It is interesting, also, that around such playas the plants frequently occur in well-marked bands or zones. Where the zones are found there is probably little difference in the available moisture or the soil temperature and it is suggested that the zonal differentiation may be a result of unlike response of the roots of the plants comprising the zones to the atmosphere of the soil. Whether zonation is to be associated with the relation of roots to the soil atmosphere in places outside the arid regions remains to be seen, but this may well be the case.

W. A. Cannon,
E. E. Free

[2] Howard and Howard, Bulletin 52, Agricultural Research Institute, Pusa, 1915.

SCIENTIFIC EVENTS

THE WORK OF THE AMERICAN MUSEUM OF NATURAL HISTORY

ACCORDING to a press report the trustees of the American Museum of Natural History decided at their annual meeting at the home of Mr. Henry C. Frick greatly to broaden the scope of its work in aiding industrial, civil and artistic life in order to make up for some of the foreign deprivations due to the war.

Because so many American arts and industries have been thrown upon their own resources, the institution will intensify its efforts to make its collections and publications widely and fully available. A review of last year's work noted that the difficulty of obtaining new patterns for dress fabrics and other textiles from abroad has sent designers to the museum stores of American primitive and Indian art. Manufacturers of pottery and other wares, too, are sending their designers to study ancient specimens.

For the extension of the work the trustees adopted the largest budget in its history, appropriating $608,590 for the current year. They subscribed $60,000 among themselves to make up a deficit in the maintenance account in addition to $23,500 they already had subscribed to give to all employees a 10 per cent. bonus. To meet the higher cost of living it was decided to make the increased salaries permanent on a merit basis.

The income from the Morris K. Jesup endowment fund for 1917 was given as $252,500. The museum has received all but 10 per cent. of the $5,000,000 bequest, and expects to have the full amount in the course of the present year. This fund is used exclusively for scientific work, exploration, research and publication.

Dr. Henry Fairfield Osborn announced that among bequests to the institution was one of $250,000 from the estate of Amos F. Eno, of this city, and another of $100,000 from that of James Gaunt, of England. Special attention is to be given this year to the department of anthropology, for the work of which in the last ten years $456,000 has been expended.

The election of officers resulted as follows: *President,* Henry Fairfield Osborn; *First Vice-president,* Cleveland H. Dodge; *Second Vice-president,* J. P. Morgan; *Treasurer,* Henry P. Davison, and *Secretary,* Adrian Iselin, Jr. The choice of trustees for the class of 1921 resulted in the reelection of Charles Lanier, Anson W. Hand, Frederick F. Brewster and R. Fulton Cutting.

The attendance at the meeting was the largest in the history of the institution. Those present were Adrian Iselin, Jr., Joseph H. Choate, Charles Lanier, Percy R. Pyne, T. De Witt Cuyler, A. D. Juilliard, Arthur Curtiss James, Cleveland H. Dodge, John B. Trevor, Professor Henry Fairfield Osborn, Felix M. Warburg, Ogden Mills, Dr. Walter B. James, Madison Grant, Frederick F. Brewster, R. Fulton Cutting, Archer M. Huntington, Henry C. Frick and Cabot Ward.

HIGHER EDUCATION IN WASHINGTON

THE Washington legislature of 1915 appointed an educational commission of three members and three representatives to make a survey of the educational institutions of Washington (State College of Washington, University of Washington and the three normal schools). This commission secured the services of the U. S. Bureau of Education in making the survey, the results of which were recently published as a bulletin by the Bureau of Education. This report recommended the transference of the graduate work in engineering and pure science from the state college to the university, also the transference of several departments from the college to the university. The matter was brought before the present legislature in the form of a bill putting into effect the provisions of this report. This bill, however, failed of passage and in its stead a substitute bill was passed providing:

Sec. 2. The courses of instruction of the University of Washington shall embrace as exclusive major lines, law, architecture, forestry, commerce, journalism, library economy, marine and aeronautic engineering and fisheries.

Sec. 3. The courses of instruction of the State College of Washington shall embrace as exclusive major lines, agriculture in all its branches and

subdivisions, veterinary medicine and economic science in its application to agriculture and rural life.

Sec. 4. The courses of instruction of both the University of Washington and the State College of Washington shall embrace as major lines, liberal arts, pure science, pharmacy, mining, civil engineering, electrical engineering, mechanical engineering, chemical engineering, home economics, and the professional training of high-school teachers, school supervisors and school superintendents. These major lines shall be offered and taught at said institutions only.

Sec. 5. Work and instruction in medicine when introduced or developed shall be offered and taught at the University of Washington exclusively.

The bill further provides for a joint board of higher curricula of nine members chosen from the presidents and regents of the five state institutions of higher learning. In the future all major lines of work taken up by any institution of higher learning of the state must first be passed upon and approved by a two thirds vote of said board of higher curricula.

In addition to this, an act was passed granting in perpetuity to the State College all of the federal land formerly allotted to the state for a scientific school and further provided:

Sec. 2. All funds granted by the United States government under the Morrill act, passed by congress and approved July 2, 1862, together with all acts amendatory thereof and supplementary thereto, for the support and in aid of colleges of agriculture and mechanic arts, as well as experiment stations and farms and extension work in agriculture and home economics in connection with colleges of agriculture and mechanic arts are hereby allotted to the State College of Washington.

GRANTS FOR SCIENTIFIC WORK FROM THE LOUTREUIL FUND

Nature quotes from the *Comptes rendus* of the Paris Academy of Sciences the report of the council of the Loutreuil Foundation. The grants allotted are divided into three groups, as follows:

Establishments Mentioned by the Testator.—(1) Museum of Natural History. Two thousand francs to Professor Louis Roule for the continuation of his researches on the migratory fishes of French marine and fresh waters, the Salmonidæ in particular. Ten thousand francs for refitting the maritime laboratory of the Island of Tatihou at Saint-Vaast-La-Hougue. This laboratory has been used as a concentration camp since the outbreak of war, and considerable damage has been done. (2) The Collège de France. Seven hundred francs to E. Gley to complete the frigorific installation for which an allocation was made last year. Four thousand three hundred and fifty francs to Professor Nageotte for the purchase of apparatus for pursuing his studies on the regeneration of nerves. Four thousand francs to M. l'Abbé Rousselot for continuing and developing the experiments commenced by him on locating artillery by sound. (3) Conseil Central des Observatories. Fifteen thousand francs to the Observatory of Paris for the improvement of astronomical instruments applied to the determination of time. One thousand five hundred francs to the Observatory of Marseilles for ensuring the publication of the *Journal des Observateurs.* (4) Ecole Nationale Vétérinaire d'Alfort. Seven thousand francs to this school for the purchase of an apparatus for kinematographic registration and projection; this will be of great service in the study and demonstration of various movements in the normal or pathological state. (5) Ecole Nationale Vétérinaire de Lyon. Eight hundred and fifty francs to Charles Porcher for the purchase of instruments to be used in his researches on milk. Eight hundred francs to François Maignon for the purchase of a balance and a small hydraulic press, to be used in his researches on nutrition. (6) Ecole Nationale Vétérinaire de Toulouse. Five thousand francs to this school for a radiological installation to be used in the diagnosis of diseases of animals.

Establishments Nominated to the Committee by the President of the Academy.—(1) Conservatoire des Arts et Métiers. Four thousand francs to Louis Blaringhem for the creation of a typical collection for the determination and classification of the woods used in the aeronautic industry. Five thousand francs conditionally to James Dantzer for the creation of a laboratory for the testing of textiles,

fibers, and tissues under the express condition that the Union des Syndicats Patronaux de l'Industrie Textile contributes the same amount. (2) Ecole Nationale Supérieure des Mines. Ten thousand francs to this school for completing the laboratory installation, especially as regards motive power. (3) Institut Catholique de Paris. Two thousand francs to Henri Colin for the purchase of apparatus not usually found in botanical laboratories, to be used in his researches on the conditions of destruction of various bacilli. Two thousand francs to Jules Hamonet for purchasing apparatus for determining the physical constants, particularly refractive indices, of the new substances he has discovered in the glycol group.

Various Direct Requests for Grants.—Ten thousand francs to Jules Garçon for the preparation of a bibliography of bibliographers, a part to be used in making an inventory of the scientific periodicals contained in the libraries of Paris. Three thousand francs to Guillaume Bigourdan for the construction of an angle comparator for measuring the variation which the angular distance of two stars may show in a short interval of time. Three thousand francs to Henri Bourget for his researches on astronomical photometry. Two thousand francs to A. Colson for continuing his researches on solutions. Seven thousand francs to Augustin Mesnager for improving the equipment of the laboratory for testing materials under his direction at the Ecole des Ponts et Chaussées. Two thousand francs to Jules Glover for continuing his researches on telephony. Seven thousand francs to Louis Joblin to complete the publication of his studies relating to the material collected in the second Antarctic voyage of Jean Charcot. Five thousand francs to the Société de Documentation Paléontologique. Two thousand francs to J. M. R. Surcouf for assisting the publication of his work on horse-flies.

The total amount in grants is 115,200 francs.

SCIENTIFIC NOTES AND NEWS

DR. VERNON M. SLIPHER, for many years chief assistant at the Lowell Observatory, known for his spectroscopic researches, has been appointed director of the Lowell Observatory in succession to the late Percival Lowell.

PROFESSOR GEORGE S. MOLER, of the department of physics of Cornell University, will retire from active service at the end of the academic year.

AT a meeting of the Rumford Committee of the American Academy of Arts and Sciences, held on February 14, 1917, the following grants for researches in light or heat were made: To Professor F. K. Richtmyer, of Cornell University, five hundred dollars in aid of his researches on the optical properties of thin films; to Professor Norton A. Kent, of Boston University, four hundred dollars additional to previous appropriations in aid of his research on spectral lines; to Mr. Ancel St. John, of the Worcester Polytechnic Institute, two hundred dollars in aid of his research on the spectra of X-rays.

AT the New York meeting of the Botanical Society of America officers for 1917 were announced as follows: *President,* F. C. Newcombe, University of Michigan; *Vice-president,* E. W. Olive, Brooklyn Botanic Garden; *Treasurer,* E. W. Sinnott, Connecticut Agricultural College at Storrs. R. A. Harper, Columbia University, became a member of the council, and also of the editorial committee of the *American Journal of Botany.* The representative of the American Phytopathological Society on the journal committee is Professor Aaron G. Johnson, University of Wisconsin.

PROFESSOR GEORGE HAYEM has been elected president of the Paris Academy of Medicine for 1918.

THE Janssen prize of the Paris Academy of Sciences has been awarded to MM. Ch. Fabry, Henri Buisson and Henry Bourget, for their researches on the determination of the temperature and evaluation of the atomic weights of the unknown gases in the nebula of Orion.

WE learn from *Nature* that the president of the British Board of Agriculture and Fisheries has appointed a committee of representative agriculturists to advise him on questions arising in connection with the increased production of food. The committee is constituted as

follows: The Right Hon. R. E. Prothero (chairman), the Right Hon. Sir Ailwyn E. Fellowes (vice-chairman), the Right Hon. F. D. Acland, the Right Hon. Henry Hobhouse, the Hon. Edward G. Strutt, Sir Sydney Olivier (board of agriculture), Mr. W. W. Berry (Development Commissioner), Mr. S. W. Farmer, Mr. F. L. C. Floud (board of agriculture), Mr. A. D. Hall (Development Commissioner), Mr. S. Kidner, Mr. T. H. Middleton (board of agriculture), Mr. A. Moscrop, Mr. H. Padwick (National Farmers' Union), Mr. R. G. Paterson, Mr. G. G. Rea, Mr. E. Savill, Mr. Leslie Scott and Professor W. Somerville. Mr. E. M. Konstam (who has joined the department for the duration of the war) is the secretary of the committee.

The 1916 volume of the *Annals* of the Association of American Geographers, which has just appeared, contains a long descriptive article by Professor N. M. Fenneman on "The Physiographic Divisions of the United States." This is accompanied by a map, the work of a committee of the association consisting of Professors Fenneman, Blackwelder and D. W. Johnson and Messrs. Campbell and Matthes, of the U. S. Geological Survey. Separates and copies of the map may be obtained on application to Richard E. Dodge, secretary, Washington, Conn.

Professor Lafayette B. Mendel, of Yale University, addressed the Sigma Xi Society of the University of Chicago on February 2, and also spoke to the students of the university on the subject of "Nutrition."

Dr. Harry N. Holmes, head of the department of chemistry at Oberlin College, lectured recently on "The Formation of Crystals" at the Mellon Institute of the University of Pittsburgh; Franklin Institute, Philadelphia, and the Johns Hopkins University.

Surgeon-General Sir G. H. Makins, delivered the Hunterian oration before the Royal College of Surgeons of England on Wednesday, February 14, his subject being the influence exerted by the military experience of John Hunter on himself and on the military surgeon of to-day.

On February 28 the Geological Society of London will again have the opportunity of discussing the Piltdown man. The late Charles Dawson had discovered further remains about a mile away from the original locality, but in gravel of the same age. These, which consist of a molar from the lower jaw, a fragment of the occiput, and a part of a frontal including some of the orbital margin, will be laid before the meeting by Dr. A. Smith Woodward.

A movement has recently been initiated to institute, at the Finsbury Technical College, a reference library of chemical books in memory of the late Professor Raphael Meldola, F.R.S., who formerly presided over this school of applied chemistry.

Charles J. White, professor emeritus of Mathematics at Harvard University, died suddenly on February 12.

Mr. John Tebbutt, of Windsor, New South Wales, where he conducted an observatory, has died at the age of eighty-two years.

The death in Rio Janeiro is announced of Dr. Oswaldo Cruz, director of the Oswaldo Cruz Institute of Pathology and Bacteriology, Dr. Cruz was formerly director of the Brazilian sanitary service.

The spring meeting of the American Chemical Society will be held in Kansas City, April 10–14. The program will be arranged as follows:

Tuesday night, April 10—council meeting.
Wednesday morning, April 11—opening session.
Wednesday afternoon, April 11—opening session, continued, or section meetings.
Wednesday night, April 11—smoker.
Thursday morning, April 12—section meetings.
Thursday afternoon, April 12—section meetings.
Thursday night, April 12—banquet, or open.
Friday morning, April 13—section meetings.
Friday afternoon, April 13—excursions.
Friday night, April 13—banquet, or open.
Saturday morning, April 14—excursions.

The Geological Department of the British Museum has recently received, through Sir John Eaglerome, K.C.M.G., an interesting series of vertebrate remains from early Tertiary beds in southern Nigeria. These include a huge carinate bird (*Gigantornis eagleromei*

Andrews, 1916) remains of leathery turtles, and jaws of a primitive Zeuglodont, showing approximation to a creodont dentition.

DR. HENRY J. BERKLEY, clinical professor of psychiatry in the Johns Hopkins University, has presented the library with a number of rare and valuable medical books, dating from the sixteenth, seventeenth and eighteenth centuries.

IN connection with the presentation on January 20 of a loving cup to Mr. Thomas A. Forsyth, one of the founders of the Forsyth Dental Infirmary for Children, Boston, the institution was open for public inspection, both forenoon and afternoon, as it is to be known as "Forsyth Day." Routine work as well as special features were shown in all departments. In the orthodontia department special cases were shown, and in the surgical department, special operations were conducted by Dr. William E. Chenery. Fifteen-minute lectures by John D. Adams, M.D., and Isadore Coriat, M.D., were given on subjects of interest to dentists at 11:30. A research laboratory exhibit was given from 2 to 4 P.M.

Two skeletons of the duck bill dinosaur were lost to science with the sinking recently by a German raider of the ship *Mont Temple,* according to Charles H. Sternberg, of Lawrence, Kans., who found the bones in the red deer country in Alberta, Canada. The prehistoric specimens were thirty-two feet long and were being sent to the British Museum. They filled twenty-two boxes and weighed 20,000 pounds. When the shipments failed to arrive in England, an inquiry was made by Mr. Sternberg and he received word from the Canadian railroad officials of the fate of the shipment.

THE United States Department of the Interior has designated Minnesota as one of the three states where mining experiment stations are to be established within a year. The government will appropriate $25,000 annually for the support of such a station and the state must supply the building. The regents have asked for $175,000 for this purpose. There are to be ten such stations established eventually. Minnesota's importance as a mining state has caused her to be selected as one of the first group.

THE University of Toronto, through the Antitoxin Laboratory in the Department of Hygiene, has recently been the recipient of a gift from Colonel A. E. Gooderham, Toronto, of a farm of fifty acres on which have been erected model stables and laboratories for the work of the laboratory. The value of the gift exceeds $60,000, and the farm is situated within twenty miles of Toronto. It prepares all the public health biologic products supplied free by the Ontario government, through its board of health, including diphtheria and tetanus antitoxin, anti-meningitis serum, the Pasteur Treatment and smallpox vaccine. The laboratory also prepares all the tetanus antitoxin used by the Canadian Expeditionary Forces. The director of the laboratory is Dr. J. G. Fitzgerald, associate professor of hygiene, University of Toronto.

THE HON. ALBERT JOHNSON writes from the United States House of Representatives:

> I tried, immediately on the opening of the session, to obtain a hearing for House Bill 528, for the discontinuance of the Fahrenheit thermometer. With only 52 working days between January 1 and March 4, it is evident that not only this bill, but many other important bills will have no chance to come up for action. The hearing before the committee would have to be repeated at the next session, when the composition of the committee may be very different. The new committee might be influenced to some extent by the report of its predecessor, but such reinforcement of the argument is hardly needed, and would at best be of little weight. It seems to me that any advantage thus to be gained would hardly justify the labor of getting the committee together at a time when its members, like myself, are overwhelmed with other pressing work. In the new Congress, the bill will have to be reintroduced, either at the special session, which now seems a probability, or at the regular session. I shall then make an effort to obtain a hearing with the least possible delay.

THE chemical industry in Russia has received great impetus from the war, and, according to *Commerce Reports,* quoted by the *Journal* of the American Medical Association, a number of works have already been erected

and many others are projected. Among them is a formaldehyde factory at Vetluga, and a technical laboratory for the production of lanolin, naphthalene, etc., at Rostov. A large company has been formed at Moscow for the production of coke-benzol products and at Tomsk a chemical factory is projected for the making of medical chemicals. Several new works for making sulphuric acid have been erected in the Volga region, in the Donets basin, in the Caucasus and in the Urals. Mirrors, lenses and other optical instruments, thermometer tubing and chemical glass, formerly imported, are now being made. There is a large demand for microscopes and other scientific apparatus, as well as for articles for medical and surgical use.

At a meeting of the board of managers of the Cold Spring Harbor Biological Laboratory of the Brooklyn Institute of Arts and Sciences, the completion of an endowment of $25,000 for the laboratory was announced. The principal donors are: Mr. W. J. Matheson, estate of Colonel Robert B. Woodward, Mr. Walter Jennings, Mr. A. A. Healy, Mr. August Heckscher, Mr. Cleveland H. Dodge, Mr. Louis C. Tiffany, Mr. Howard C. Smith, Mrs. E. H. Harriman, Colonel T. S. Williams, Mr. Henry F. Noyes, Mr. Albert Strauss and Mr. Donald Scott. It is expected that the laboratory will now become one of the four fundamental departments of the institute, and will be under the special care of a governing committee of the trustees of the institute.

Although New York was not included among the states where a serious fungous disease of poplars was reported by the federal authorities, the State College of Agriculture at Ithaca announces that the disease has been found on Long Island. This disease is similar in appearance to that which destroys the chestnut trees and may be found on any species of poplars or cottonwoods. Trees attacked by this fungus show cankers or depressed areas in the bark, which spread rapidly and often girdling the twig, limb or trunk of the tree and killing the part above the canker; the trees become ragged in appearance and finally die. This is especially true of the Lombardy poplars so often planted in rows along highways. The fungus which causes this disease, according to the authorities, was imported from Europe, and is especially severe on stored and transplanted nursery stock. The centers of infection appear to be, in every case, either certain nurseries known to contain diseased trees, or points where poplars from such nurseries have been planted. Residents of New York who think their trees are affected by the disease may receive exact information by sending samples to the department of plant pathology, New York State College of Agriculture, Ithaca, New York.

The Rizzoli Orthopedic Institute of Bologna has inaugurated an exposition of orthopedic appliances, to be held at Bologna in February under the auspices of the national federation of committees engaged in welfare work for blinded, mutilated and crippled soldiers. The institute has announced a prize of 5,000 lire for the best appliance, and is urging others to collect funds for additional prizes.

Professor L. C. Karpinski writes that the first volume of the "Nouvelles Tables trigonométriques fondamentales" by Professor H. Andoyer, of Paris, mentioned in a recent review in Science as delayed by the war, appeared in 1915. This volume of 341 pages + lxviii pages includes the sines and cosines for each one hundredth of the quadrant to 20 decimal places, for each 9 minutes to 17 places, and for each 10 seconds to 15 decimals.

UNIVERSITY AND EDUCATIONAL NEWS

A gift of $20,000 from Mrs. George Putnam to Harvard University was announced at the last meeting of the president and fellows. The money will be used to establish a fund in memory of Mrs. Putnam's brother, James Jackson Lowell, and the income will be used for the purchase of books for the college library.

Thirty-four thousand guineas have been subscribed to the South Wales University College for the extension of scientific and technical education.

THE University of Stockholm has received from Mrs. Amanda Ruben the sum of 50,000 kroner to found a readership in experimental zoology.

DR. B. C. CROWELL, professor of pathology and bacteriology, University of the Philippines, has been appointed director of the Graduate School of Tropical Medicine and Public Health of that university. This school gives courses which in one year lead to the degree of Doctor of Tropical Medicine and in two years to Doctor of Public Health.

DR. H. B. FANTHAM, of Christ's College, Cambridge, has been appointed to the professorship of zoology at the South African School of Mines and Technology, Johannesburg, and Dr. C. E. Moss, of Emmanuel College, has been appointed professor of botany in the same institution.

WE learn from *Nature* that Dr. Johanna Westerdijk has been appointed associate professor of phytopathology in the University of Utrecht. She is said to be the first woman to receive such an appointment in Holland.

DISCUSSION AND CORRESPONDENCE

THE LIMIT OF THE SPECTRUM IN THE ULTRA-VIOLET

IN the *Astrophysical Journal* for March, 1916, I gave an account of my work in the extreme ultra-violet. During the past year I have continued my investigations in the same field; the results have not been commensurate with the labor, but it is perhaps worth while to make a brief report of them.

I have not changed the general design of my spectroscope but I have replaced the 100 cm. grating by one of 50 cm. radius, thus halving the light path and considerably reducing the volume to be exhausted. My source of light is still a quartz discharge tube, but I have so altered the design that the end of the capillary can be brought much nearer the slit of the spectroscope than before; I have considerably increased the potential of the transformer; as before, I employ helium at one or two millimeters pressure to fill my spectroscope and discharge tube.

The net result of these changes is that I have certainly extended the spectrum from 600 to the neighborhood of 510 Ångströms; a trace of a line exists on my very best negative near 450 Ångströms, but it is far too faint to afford trustworthy evidence.

From time to time during the past five or six years I have tried Wood's miniature arc in vacuum, and a variety of vacuum spark arrangements, recently I have repeated the more promising of these experiments. None of these sources appear to yield lines in the most refrangible region. Helium continues the most promising source.

THEODORE LYMAN
JEFFERSON PHYSICAL LABORATORY,
HARVARD UNIVERSITY, CAMBRIDGE,
February 14, 1917

THE FOUNDATIONS OF DYNAMICS AND DADOURIAN'S ANALYTICAL MECHANICS

MY attention was called recently to a review of the second edition of my "Analytical Mechanics" by Professor E. W. Rettger, which appeared in SCIENCE (No. 1130) last summer when I was in the mountains and did not see it. The review on the whole was favorable and would not have tempted the author of the book to make an answer at this late date were it not for the fact that the two questions raised by the reviewer bear upon the foundations of the science of mechanics.

The first of these is directed against my direct application of the laws of vectors to the directed magnitudes of mechanics:

> Before we apply the law of vector addition to any kind of quantity, ought we not first assure ourselves that the parallelogram law holds for these quantities? Since force, for instance, is a *directed quantity* (italics are mine) does it follow that the parallelogram law holds for forces?

I would answer both of these questions in the affirmative. We have no right to apply vector operations to "any kind" of quantity. We ought to assure ourselves that the quantity in question is a "directed quantity" before treating it as such. But having once assured ourselves of this fact we need not hesitate to apply to it the parallelogram law or any other law of directed quantities.

Vector algebra is the science of directed lines, or displacements, in space as ordinary algebra is the science of numbers. We do not hesitate to apply the laws of ordinary algebra to quantities which can be represented by numbers, we need no more have any compunction about applying the laws of vectors to quantities which can be represented by directed lines. The expression "the law of parallelogram of forces" is a provincialism for which there is about as little justification as there would be for a "law of the addition of apples" in arithmetic. The addition law of arithmetic is a law of numbers and is not peculiar to apples; it can be applied to apples not because they have certain desirable properties, but because they can be counted. Similarly, the parallelogram law is a law of displacements or directed lines, and not at all characteristic of forces, but it can be applied to forces because these have among other physical properties those of direction and of magnitude and consequently may be represented by directed lines.

This is the precise point of view which I have adopted in my book toward the directed magnitudes of mechanics. After giving a clear and concise exposition of the laws of addition and resolution of vectors in the first chapter I have applied them to directed quantities without hesitation. This mode of procedure is not only correct, but it is straightforward and simple, as the reviewer admits when he says:

> **If the author is correct . . . then certainly the theory underlying the composition and resolution of directed quantities becomes very simple.**

The second question which Professor Rettger raises has to do with my formulation of the principle underlying the science of dynamics. In my book I have based dynamics upon the following principle, which I have called the *action principle:*

The vector sum of all the external actions to which a system of particles or any part of it is subject at any instant vanishes.

$$\Sigma \mathbf{A} = 0.$$

A particle may be acted upon by other particles and by the ether. The action of one particle upon another particle is known as a force. The action of the ether upon a particle I have called a *kinetic reaction.* Therefore the action principle states

$$\Sigma(\mathbf{F} + \mathbf{q}) = 0,$$

where $\mathbf{F}$ denotes a force and $\mathbf{q}$ a kinetic reaction. The kinetic reaction on a particle is oppositely directed from and proportional to the acceleration and the constant of proportionality is the characteristic constant of the particle known as mass. Therefore we have

$$\Sigma(\mathbf{F} - m\,\mathbf{a}) = 0.$$

Commenting upon this principle, Professor Rettger says:

> **The reviewer does not wish to say that the author is wrong in his conception. All he wishes to say is that he entirely fails to appreciate the author's point of view.**

This lack of appreciation is due, it seems to me, to a lack of clear understanding, indicated by the following questions, of the nature and function of the kinetic reaction.

> **Why is it that the ether acts on a body only when it is being accelerated and not when the body is moving with constant velocity?**
>
> **If kinetic reaction is the action of the ether on a particle, and if it is the same kind of a quantity as force (is a force in fact), and if the resultant force F acting on a particle and the kinetic reaction q are always equal in magnitude but opposite in direction (both equal to ma in magnitude), why is the body not in equilibrium?**

If in the first of these questions the term "why" is used in the metaphysical sense, there is no answer for it, except possibly the equally metaphysical answer "because." On the other hand, if it is used to mean "how is this fact correlated with other facts?" I would state that the answer belongs to electrodynamics and not to mechanics and would refer the reviewer to a modern treatise on electrodynamics, Lorentz's book on "Electron Theory," for instance, where the question is answered at length.

Answering the second question, one might state: "The body is not in equilibrium for the same reason that a particle revolving in a circle is not in static equilibrium in spite of

the fact that the so-called 'centrifugal' and 'centripetal' forces acting upon the particle are equal and oppositely directed." I am afraid the reviewer has overlooked the fact that a particle is in static equilibrium when and only when the sum of the forces due to other material bodies acting upon the particle equals zero. When this condition is not satisfied the particle is accelerated and by virtue of the acceleration the kinetic reaction comes into play. This kinetic reaction is equal and opposite to the resultant of the forces due to the material bodies. If it were not for the kinetic reaction a finite force would have given a body an infinite velocity in a finite time.

The kinetic reaction is of the same nature as a force and might be called a force, but that would tend to confound the cause with the effect. It would further necessitate changing the statement of the conditions of equilibrium as well as of motion. It was in order to keep the old concept of force as an action which causes acceleration and to distinguish between cause and effect that I refrained from applying the term force to kinetic reactions.

The concept of kinetic reaction is not new. It has been known to other authors of textbooks of mechanic as *centrifugal force, inertia force,* or *inertia reaction.* The thing that is new about kinetic reaction in my book is the full recognition it receives and the clear cut treatment which differentiates it from accelerating forces. I have preferred the name kinetic reaction to inertia reaction because it is just as much an acceleration-reaction as an inertia-reaction.

I claim that the point of view which I have adopted in my book has important philosophical and pedagogical advantages over the common point of view. The former has enabled me to differentiate between purely geometrical laws and dynamical principles, between kinematical relations and dynamical equations, between what is fundamental and what is derived in mechanics. I have postulated a single dynamical principle which is not only simple and sound, but is correlated with the equally fundamental principles of electrodynamics. Upon this single principle I have based the entire subject, deriving from it all the other dynamical laws and principles used in elementary mechanics, such as Newton's three laws of motion, the principles of the conservation of energy, of linear momentum and of angular momentum.

Before closing this communication I would like to call the attention of teachers of mechanics to the following principle which I have introduced in the second edition of my book and have called it the *angular action principle.*

The vector sum of all the external angular action to which a system of particles or any part of it is subject at any instant vanishes:

$$\Sigma \mathbf{A}_a = 0,$$

or

$$\Sigma (\mathbf{G} + \mathbf{q}_a) = 0,$$

where $\mathbf{G}$ denotes the moment of force about a given axis and $\mathbf{q}_a$ denotes the moment of the kinetic reaction of a particle about the same axis, the latter I have called the *angular kinetic reaction.* This principle, which is directly applicable to rotating systems, is equivalent to and derived from the action principle.

It can be easily shown from the angular action principle that the torque equation

$$G = I \frac{d\omega}{dt}$$

holds good only when the center of mass of the moving system remains at a constant distance from the axis of rotation, a point which has eluded most authors of textbooks of mechanics.

In conclusion I would state that the two action principles are simple statements of the following two sets of equations used in general dynamics.

$$\begin{aligned}
&\Sigma(X - m\ddot{x}) = 0,\\
&\Sigma(Y - m\ddot{y}) = 0,\\
&\Sigma(Z - m\ddot{z}) = 0,\\
&\Sigma[y(Z - m\ddot{z}) - z(Y - m\ddot{y})] = 0,\\
&\Sigma[z(X - m\ddot{x}) - x(Z - m\ddot{z})] = 0,\\
&\Sigma[x(Y - m\ddot{y}) - y(X - m\ddot{x})] = 0.
\end{aligned}$$

H. M. DADOURIAN

YALE UNIVERSITY

THE SYNCHRONIC BEHAVIOR OF PHALANGIDÆ

PROFESSOR H. H. NEWMAN'S note in a recent number of SCIENCE reminds me that in 1901 I

made precisely the same observations on the behavior of colonies of the same species of harvestmen (Phalangidæ) in the neighborhood of Austin, Texas. These colonies are not uncommon, nesting in masses on the lower surfaces of overhanging rocks along the canyons of the Colorado River and its tributaries and in the Edwards Plateau region. The colony described by Newman was unusually large, as I do not recall seeing any that were much more than a foot or a foot and a half in diameter and comprising, perhaps, between two and three hundred individuals. The rhythmic, simultaneous, up and down movement of the creatures on their long sensitive legs, when disturbed, is very striking. Merely approaching the spot where the Phalangids are congregated is sufficient to set the whole assemblage vibrating. The stimulus in this case is probably the air-current produced by the sudden approach of the observer and is probably propagated, as Newman suggests, by contact among the interlaced legs. In many cases of synchronic behavior, however, other stimuli must be assumed. In fireflies the initiation of the simultaneous flashes must be due to optic stimuli, as it is in people endeavoring to keep in step with one another, but the continuation of the established rhythm would seem to depend on a kind of "Einfühlung." Such is undoubtedly the impression produced on one who witnesses the rapid wheeling movements of a herd of prong-horned antelopes on our western plains or the flight of certain birds. Some years ago I observed that pelicans flying in single file over the Bay of Panama exhibited a very pronounced synchronism in the beat of their wings. In this case I was led to assume that after the members of a flock had established the synchronism, probably by visual stimuli, it was kept up by a fine sense of rhythm on the part of each individual.

W. M. Wheeler

Bussey Institution

MORE COMPLETE TITLES

To the Editor of Science: When the student of the structure or the functions of animals needs to consult the literature dealing with any form on which he has worked, he meets at the outset with the difficulty that a large number of papers to which he turns fail to show in their titles the names of the animals that were used.

In view of this familiar, but none the less unfortunate, state of affairs, I wish to inquire through your columns whether there is any valid objection to the suggestion that authors in some way incorporate in their titles the names of the animals used for their investigations.

In some cases common names would answer, but more often the binomial Latin form would be required. In the case of little known forms, and especially in the case of insects, it would be of great help if the family or order were also given.

Should there be no serious obstacle to the step here suggested, the improvement could easily be inaugurated by the concerted action of the editorial boards of our several biological journals and those heads of departments and bureaus through whose hands forthcoming manuscripts naturally pass.

Henry H. Donaldson

The Wistar Institute,
Philadelphia, Pa.,
February 3, 1917

SCIENTIFIC BOOKS

Milk and Its Hygienic Relations. By Janet E. Lane-Claypon, M.D., D.Sc. Longmans, Green & Co. 1916.

This admirable book has been published under the direction of the Medical Research Committee (National Health Insurance, England). The chief aim of the author "is to present a survey of the existing knowledge upon such aspects of the milk question as hitherto has been inaccessible or difficult to obtain by most of those desiring it."

The scope of the book includes a consideration of the composition, "biological properties," and cellular content of milk; the nutritive value of raw, boiled and dried milk; the presence of organisms liable to cause disease, and milk-borne epidemics; the sanitary production of milk, types of bacteria, methods of

heating milk and the presence of pathogenic bacteria in butter and cheese.

Foreign sources have been drawn upon exhaustively, and complete bibliographies are listed at the end of each chapter.

Of special interest are the chapters dealing with the nutritive value of raw, boiled and dried milk in infant feeding. A strong case is made in favor of boiled milk, which will be a matter of gratification and confirmation to pediatricians who are championing this cause in America. The evidence for dried milk is not convincing, but in general is favorable.

The chapters on the production of milk and "Methods Commonly Used in Heating Milk" are disappointing. In the former we are surprised to learn that in England "there are no means for keeping milk cool during transit" and the author does not insist upon the need for this. So important a matter as the grading of milk is relegated to the appendix! Pasteurization is inadequately treated. The practise is exceptional in England, but this seems no excuse for not presenting a fuller discussion.

The text includes 348 pages and 8 plates. Non-technical summaries of each chapter precede the more detailed discussion, which is a great convenience to the reader. The book is a most valuable contribution to our literature on milk.

C. M. HILLIARD
SIMMONS COLLEGE

Fungoid and Insect Pests. By F. R. PETHERBRIDGE. Edited by MESSRS. T. B. WOOD and E. J. RUSSELL, under the Farm Institute Series, 1916. Pp. 174. Cambridge University Press.

This little book is well printed and well illustrated but is not extensive enough as to the number of diseases and pests discussed to justify the title. It can hardly serve as a very general reference for farmers and market gardeners as the authors have hoped. The life histories and remedial measures for some fungus and insect pests are taken up. As a short reading text or bulletin to familiarize the public with mycological methods and to indicate possible remedial measures for control of a few pests, it contains interesting matter.

In their introductory parts—1 and 2—the authors have not drawn as close distinctions as to what constitutes diseases as might be wished. It is now hardly allowable to teach that plant diseases may be caused by "unsuitable surroundings such as unfavorable conditions of soil or weather," nor have they made very clear the distinction between infectious diseases and the ravages of animal or insect pests. Note for example: "We have dealt with some of the plant diseases caused by fungi and will now turn our attention to those caused by members of the animal kingdom. By far the greater number of these diseases are due to the ravages of insects."

Insects are effective carriers of disease, but it is safe to say that there are few farmers who would think of the work of the cabbage-leaf butterfly, the wire worm, the army worm, the May beetle or of grain weevils as diseases.

The strongest feature, perhaps, consists in the suggestive statement of remedial measures associated with each disease or insect under consideration. The facts are, generally, well grouped, though in some cases the subjects of chapters and the text overlap, as in Chapters 2 and 3. On page 46 there is a particularly good photograph of common potato scab over the legend: "Figure 15. Potato Scab—the cause of which is not known." No other discussion is given upon this disease and thus the facts are not properly conveyed. Bearing further on the limited scope of the text, no mention is made of any diseases of small fruits or of orchard and shade trees and but slight attention is given to the commonest garden crops.

H. L. BOLLEY
NORTH DAKOTA AGRICULTURAL COLLEGE

SPECIAL ARTICLES

IS SPECIES-SPECIFICITY A MENDELIAN CHARACTER?

IN a recent book[1] the writer raised the question whether or not the phenomena described

[1] "The Organism as a Whole," G. P. Putnam's Sons, New York, 1916.

under the name of genus- or species-specificity are Mendelian in character. It is obvious that a definite answer to this question would be of fundamental importance for the problem of evolution. If species-specificity is not a Mendelian character, we are confronted with the possibility that Mendelian mutations may not have been the only essential factor in evolution.

The phenomena of species-specificity are, as far as we know at present, exclusively determined by the proteins. Phenomena of cytolysis by foreign blood or extracts of foreign tissues, the precipitin and the anaphylaxis reactions can apparently not be produced by any other constituent of an organism than the proteins; and the two or three exceptions reported to this general rule may have been due to impurities in the substances used for the experiments.

A decision of the question of heredity mentioned might be possible by comparing the species-specificity of a hybrid with that of the two parent forms. If it could be shown that the species-specificity of a F_1 hybrid is identical with that of only one of the two parents, no matter whether this parent is the paternal or maternal species, we might consider this an indication that species-specificity is Mendelian; if the species-specificity of a F_1 hybrid, however, is always identical with that of the maternal form, no matter from which of the two parent forms the mother is selected, it might indicate that the cytoplasm of the egg determines the inheritance of the species-specificity.

Experiments of this kind meet with the difficulty that only closely related species can be crossed successfully and in closely related species the differences in species-specificity are generally too uncertain to permit a definite conclusion. In the splendid work of Reichert and Brown on the "Differentiation and Specificity of Corresponding Proteins and other Vital Substances in Relation to Biological Classification and Organic Evolution,"[2] it has been shown that the corresponding hemoglobins of different species are not identical, and "that their peculiarities are of positive generic specificity and even much more sensitive in their differentiation than the precipitin test." In their book they describe the hemoglobin crystals of the horse and the mule, but not those of the donkey. It seemed of interest to make the series complete in order to find out whether or not the hemoglobins of the mule resemble more closely the maternal or paternal form. A decisive result in favor of a Mendelian origin of the specificity could only be had if the hemoglobin crystals of the F_1 hybrid were identical with those of only one of the two parent forms, otherwise the result would decide neither for nor against a Mendelian inheritance of species-specificity.

The writer obtained donkey blood, the hemoglobin crystals of which were prepared and analyzed by Professor A. P. Brown, of the department of mineralogy at the University of Pennsylvania, who was kind enough to communicate his results to me in a letter which with his permission I take the liberty of publishing here.

May 4, 1916

Dear Dr. Loeb: I suppose you have come to the conclusion that I have forgotten all about your samples of the donkey blood, containing no oxalate, which you so kindly sent me; but I have been working upon them as my time permitted and I think that I can now venture to state that in the orthorhombic [or what I have called the "α-oxyhemoglobin"] constant differences may be observed; and these indicate that in this substance the blood of the donkey more closely resembles the blood of the horse than it does that of the mule. I place more weight upon the results obtained from the *orthorhombic* crystals than upon those deduced from the *monoclinic* crystals for the reason that the monoclinic crystals obtained from all three bloods show a strong tendency to twin and these twins are what we call "mimetic twins." The name "mimetic" is applied to them because they mimic or imitate a higher grade of symmetry than they really possess. For instance, these monoclinic crystals approach in their angles those of the hexagonal system and are indeed what we call pseudo-hexagonal. For these somewhat plastic crystals, by the way they twin, average their asymmetries (*i. e.*, their departures from pseudo-hexagonal symmetry) until they become, in their angles,

[2] Carnegie Institution Publication, No. 116.

really hexagonal. The outline of the crystal plate then comes to be bounded by curved (not straight) lines which show the hexagonal angles at the place where this average adjustment is most perfect. This curving of the bounding outlines renders the measurements variable and these measurements I regard as untrustworthy. The true hexagonal angle is 60° or 120° and the pseudo-hexagonal (but really monoclinic) angle may be 123° or 124° or its supplement and the influence of this produces its curving. Examples of such curving outlines to these crystals produced by this sort of twinning may be seen in Reichert and Brown "Crystallography of Hemoglobin, etc.," on Plate 3, Figs. 14 and 18, and Plate 4, Fig. 19, and the "regular growth" of the methemoglobin (hexagonal) over the oxyhemoglobin crystals (monoclinic but pseudo-hexagonal) which sufficiently approaches the true hexagonal angles of the methemoglobin to enter into regular growth with this substance is illustrated on Plate 4 in Figs. 20–23 in the case of shad blood. It is this pseudo-symmetry which renders the measurements of such twinned crystals uncertain and inconstant. Fortunately this difficulty does not apply in the case of the orthorhombic crystals of the bloods under consideration, nor indeed in the case of the majority of orthorhombic crystals, although this tendency to mimetic twinning must always be borne in mind. I do not think it need be considered in the case of the orthorhombic crystals of either the donkey, horse or mule, which are the animals under consideration. But the measurements of the *monoclinic* crystals from the blood of these three animals are rendered uncertain and are made variable by this tendency to mimetic twinning. Therefore it is to the orthorhombic crystals that I must turn to formulate any conclusions as to the likenesses or the differences in these bloods. Fortunately in the unoxalated blood that you sent me the production of crystals is easy, and, while their measurement is not easy, I think that you may rely upon the results obtained; at least they are as reliable as I can make them with my present methods. The results from these orthorhombic crystals as compared with those of horse and mule are given below.

	Axial Ratio $a:b:c$	Prism Angle (Normals)	Macrodome Angle (Normals)
Horse.....	0.7467 : 1 : 0.4097	73° 30′	57° 30′
Donkey.....	0.7522 : 1 : 0.4144	73° 54′	57° 42′
Mule[3].....	0.7813 : 1 : 0.4198	76° 00′	56° 30′

[3] Donkey ♂ and horse ♀.

These measurements appear to indicate, as I said at first in this letter, that the crystals of "α-oxyhemoglobin" of the donkey approach more nearly those of the horse than they do those of the mule.

Very sincerely yours,

(Signed) AMOS P. BROWN

It is impossible to utilize these results for or against the idea that species-specificity is a Mendelian character. In view of the bearing on the problem of the inheritance of species-specificity the writer thought that even these negative results might be of some interest.

A further difficulty which besets the solution of this problem is that the terms species and genus are selected on a morphological basis and not according to the protein reactions involved in the phenomena of species-specificity.

JACQUES LOEB

THE ROCKEFELLER INSTITUTE FOR MEDICAL RESEARCH, NEW YORK

THE AMERICAN PHYSICAL SOCIETY

THE eighty-sixth meeting of the American Physical Society was held at Columbia University, December 26–29, 1916. Sessions on Tuesday afternoon, Thursday forenoon and afternoon, and Friday forenoon and afternoon were joint sessions with Section B, American Association for the Advancement of Science, and were held at the School of Journalism. The two sessions on Wednesday were joint sessions with Sections B and C and were held in Havemeyer Hall. The following program of papers was presented:

A Proposed New Form of Seismograph. Herbert Bell.

The Velocity of Sound in Gases in Metal Tubes, as a Function of Density. Karl K. Darrow.

Measurements in Frictional Electricity. L. E. Woodman and N. R. French.

The Preparation of Metallic Mirrors, Transparent Metallic Prisms and Films by Distillation. Otto Stuhlman, Jr.

Our Part in the Advancement of World Physical Science. L. A. Bauer.

Some Experiments Concerning Magnet-Photography. L. A. Bauer and W. F. G. Swann.

On Growth of Crystal Structure in Selenium. F. C. Brown.

Experimental Evidence for the Parsons Magneton. L. O. Grondahl.

The Effect of Pressure on the Resistance of Metals and a Possible Theoretical Explanation. P. W. Bridgman.

The Infra-red Absorption Bands of Gases and the Application of the Quantum Theory to Molecular Rotations. Edwin C. Kemble.

A Criticism of the Rutherford-Bohr Atomic Hypothesis, based upon a Theorem of Phase Equilibrium of two Electrons. Albert C. Crehore.

A Physical Conception of the Reason for the Existence of Planck's Constant "h" based upon the Classical Electrodynamics. Albert C. Crehore.

The Magnetization of Iron, Nickel and Cobalt by Rotation and the Nature of the Magnetic Molecule. S. J. Barnett.

The Internal Structure of Atoms. A. W. Hull.

A New Count Method of Determining the Elementary Electrical Charge. Harvey Fletcher.

A Lecture Demonstration of the Capture of Ions by Falling Drops. E. P. Lewis and W. A. Shewhart.

Some Undescribed Disintegration Products of Radioactive Elements. Fanny R. M. Hitchcock.

Recent Progress in Spectroscopy. (Vice-presidential address before Section B). E. P. Lewis.

The Photo-Electric Effect of Radiations in the Extreme Ultra-violet. James Barnes.

Aluminum and Mercury Atoms under an Electric Field. Reinhard A. Wetzel.

Photography of Spectra in Red and Infra-red Regions. William F. Meggers.

A Relationship between Fluorescence and Planck's Radiation Law. E. H. Kennard.

The Infra-red Arc Spectra of the Metals of the Fe Group. H. M. Randall and E. F. Barker.

Some Spectra in the Photographic Infra-red. Charles F. Meyer.

The Effect of Longitudinal Alternating Magnetic Fields Upon the Hysteresis Curves Produced by Slowly Varying Currents in a Series of Iron-Carbon Alloys. C. W. Waggoner and H. M. Freeman.

Experiments with the Electric Furnace on the Anomalous Dispersion of Metallic Vapors. (By title.) Arthur S. King.

The Effect of Oxygen on the Production of Band and Line Spectra in the Electric Furnace. (By title.) Arthur S. King.

A Polarization Flicker Photometer. Herbert E. Ives.

Test of Absorption Screen for Optical Pyrometry. E. P. Hyde, F. E. Cady and W. E. Forsythe.

A New Direct Reading Precision Refractometer with Uniformly Divided Scale. G. W. Moffitt.

The Minimum Potential Required to Excite the Balmer Series of Hydrogen. James Barnes.

Impact of Electrons on Mercury Atoms. C. D. Child.

The Stark Effect. Reinhard A. Wetzel.

A Proposed Method for Measuring Disturbances in the Earth's Magnetic Field. (By title.) Herbert Bell.

The Kathodo-Luminescence Produced by Certain Tribo-Luminescent Salts of Zinc. (By title.) C. W. Waggoner.

Variations in Glow Discharge Produced by a Longitudinal Magnetic Field. R. F. Earhart and C. B. Jolliffe.

A Time-Current Equation for Making Iron Passive. C. McCheyne Gordon.

A Calorimetric Resistance Thermometer. S. Leroy Brown.

A New Design of Mercury-Break Buzzer for Generating Electrical Oscillations, and a Study of the Use of Other Buzzers in Radio Measurements. Chas. Moon.

The Reflectivity of Tungsten. W. Weniger and A. H. Pfund.

A Determination of C_2 of Planck's Radiation Law. (By title.) C. E. Mendenhall.

The Range of Recoil Atoms from Actinium Emanation. L. W. McKeehan.

The Intensity of X-ray Spectra. (By title.) Arthur H. Compton.

The Distribution of the Electrons in Atoms. Arthur H. Compton.

The Effect of Transverse Joints on the Magnetic Induction in Iron and Nickel. S. R. Williams.

A Resonance Method for Measuring the Phase Difference of Condensers of Fixed Capacity and a Comparison of Resonance and Bridge Methods. J. S. Ward.

The Thermophone as a Precision Source of Sound. H. D. Arnold and I. B. Crandall.

A Uniformly Sensitive Instrument for the Absolute Measurement of Sound Intensity. E. C. Wente.

Note on the Ionization Manometer. O. E. Buckley.

An Accurate Method for the Determination of Surface Tension. W. D. Harkins and F. E. Brown.

Surface Tension, Total Surface Energy, Solubil-

ity, Emulsification and Polar Setting in Surfaces. W. D. Harkins.

The Variation of the Mobility of the Negative Ion with Temperature in Air of Constant Density. Henry A. Erikson.

Intensity of Emission of X-rays from Metals. C. S. Brainin.

Extension of Recently Published Work on Ionization Potentials. J. C. McLennan.

The Significance of Certain New Phenomena Recently Observed in Preliminary Experiments on the Temperature Coefficient of Contact Potential. (By title.) A. E. Hennings.

The Energy of Emission of Photo-electrons from Film-coated and Non-homogeneous Surface. A Theoretical Study. (By title.) A. E. Hennings.

The Possibility of a Science of Experimental Meteorology. B. P. Weinburg.

A Proposed Method for the Photometry of Lights of Different Colors. (By title.) Irwin G. Priest.

At the joint sessions on Wednesday with Sections B and C of the American Association for the Advancement of Science, the following papers were presented by invitation.

Radiation and Atomic Structure. (Presidential address before the American Physical Society.) R. A. Millikan.

The Atom and Chemical Valence. G. N. Lewis.

Molecular Resonance and Atomic Structure. Robert W. Wood.

The Evolution of the Elements as Related to the Structure of the Nuclei of Atoms. Wm. D. Harkins.

The Relation of Magnetism to the Structure of the Atom. Wm. J. Humphreys.

The Relations of Magnetism to Molecular Structure. Albert P. Wills.

The Structure of Solids and Liquids, and the Nature of Interatomic Forces. Irving Langmuir.

Electromerism: A Case of Chemical Isomerism Resulting from a Difference in Distribution of Valence Atoms. Lauder W. Jones.

The following responded to invitations to discuss the papers: Wm. Duane, A. C. Crehore and K. G. Falk. Mr. Falk read the discussion of J. M. Nelson. The discussion was then thrown open and participated in by W. F. G. Swann, A. G. Webster, M. I. Pupin and others.

Many physicists attended the addresses Tuesday evening of the retiring president of the American Association for the Advancement of Science, Director W. W. Campbell, of the Lick Observatory, on "The Nebulæ," and the special program of Section D, Friday evening, on "The Inter-relationship of Engineering and Pure Science." This session was held at the Engineering Societies Building and was followed by a reception to visiting members of the A. A. A. S.

At a short business session the result of the mail ballot for the election of officers was announced. R. A. Millikan, H. A. Bumstead, A. D. Cole and J. S. Ames was reelected president, vice-president, secretary and treasurer respectively. H. A. Wilson and G. O. Squier are the new members of the council. F. Bedell is reelected managing editor, and O. M. Stewart, N. E. Dorsey and Wm. Duane are elected on the editorial board of the *Physical Review*. The reports of the treasurer and the managing editor were presented and on motion, accepted. (These will be printed and mailed to all members.) It was announced that the next meeting of the society would probably be in connection with the Midwinter Convention of the American Institute of Electrical Engineers at New York, February 14–16.

The subscription dinner on Thursday evening was attended by about eighty, and was much enjoyed. The exhibit of new apparatus and results in the Commons Building was open from 4 to 6 P.M., daily, and on Friday afternoon the instruction and research laboratories for physics in Fayerweather Hall were on exhibition with members of the teaching staff in attendance. For these courtesies and many others the society is indebted to Director Geo. B. Pegram, who also had charge of the physics portion of the apparatus exhibit.

The attendance at this meeting was record-making, about 325 at the joint sessions on Wednesday and about 200 at most of the ordinary sessions. The number of new members elected at the meeting was forty, which also probably establishes a new record.

A. D. COLE,
Secretary

SOCIETIES AND ACADEMIES

THE BIOLOGICAL SOCIETY OF WASHINGTON

THE 562d regular and the 37th annual meeting of the society was held in the Assembly Hall of the Cosmos Club, Saturday, December 16, 1916, called to order by President Hay at 8 P.M. with 23 persons present.

Annual reports of officers and committees were submitted.

Election of officers for the year 1917 resulted as follows:

President, W. P. Hay.

Vice-presidents, J. N. Rose, A. D. Hopkins, Hugh M. Smith, Vernon Bailey.

Recording Secretary, M. W. Lyon, Jr.

Corresponding Secretary, W. L. McAtee.

Treasurer, Ned Dearborn.

Members of Council, N. Hollister, J. W. Gidley, Wm. Palmer, Alex. Wetmore, E. A. Goldman.

President Hay was elected a vice-president of the Washington Academy of Sciences.

Ex-president Evermann then gave an illustrated lecture regarding the present condition of the museum of the California Academy of Science and on its aims and aspirations. Dr. Evermann's lecture was discussed by Messrs. E. W. Nelson and Vernon Bailey.

M. W. Lyon, Jr.,
Recording Secretary

The Botanical Society of Washington

The 116th regular meeting of the Botanical Society of Washington was held in the Assembly Hall of the Cosmos Club at 8 P.M., December 5, 1916, President T. H. Kearney presiding. The program of the evening consisted of a symposium on the behavior of hybrids in different groups of plants.

Mr. G. N. Collins called attention to the increased vigor of the first generation hybrids of Indian corn which is particularly marked in strains which have been widely separated geographically. Variability was found to be somewhat more characteristic of the second than of the first generation. Horny or sweet endosperm is perhaps the best example of a simple Mendelian character pair thus far encountered in maize. Horny and waxy endosperm are completely alternative but the departures do not conform to the expected ratio.

Mr. O. F. Cook stated that when distinct types of cotton are crossed there is usually evidence of increased vigor and hardiness. As a rule, the first generation is intermediate between the parents, while the splitting is pronounced in the second and later generations, but with no cases of complete return to the ancestral types. A great deal of correlation or coherence in characters is often shown in the second and subsequent generations. The increment of selection which has been developed in the parent stock previous to crossing is totally lost in hybridization.

Mr. H. V. Harlan called attention to the sharply contrasting characters in the barley group. Such characters as the following: hulled and naked, black and white, hooded and awned are inherited in the 1–3 ratio.

Among the wheats, Dr. C. E. Leighty stated that nine groups are available for hybridization. The first generation shows increased vigor and greater uniformity. Most of the characters are intermediate. In most cases the behavior in subsequent generations can be explained on the basis of Mendel's law. Wheat hybrids are often fixed and many of the good commercial strains have originated in this way.

The behavior of wheat and rye, oats and asparagus hybrids was discussed by Mr. J. B. Norton. A distinct coherence of characters is shown when naked oats are crossed with the ordinary hulled type. If *Asparagus davuricus,* a Chinese species, is crossed with *Asparagus officinalis,* the progeny resembled in most cases the Chinese mother, especially in dropping their branches in the fall. When these hybrids were crossed back with *Asparagus officinalis,* the second generation showed none of the abcission phenomena exhibited by the mother parent, although the expected ratio was 1–1.

Resistance to wilt disease in hybrids of cotton, okra, watermelon and cowpea was discussed by Dr. W. A. Orton. In the first generation of cotton hybrids, wilt resistance is dominant; in the second generation a large percentage of non-resistant plants are produced. Selected wilt-resistant plants produced a third generation with marked increase in resistance. In the case of cowpea wilt resistance is limited to a distinct variety, "the Iron." In the case of watermelon the citron or stock melon was used in breeding for disease resistance.

In hybrids of the Soy bean Mr. W. J. Morse found the characters investigated to behave as Mendelian characters and segregate according to the Mendelian ratio. The only interrelation of characters was noted in the case of the flower and the hypocotyl, white flower being associated with green hypocotyl and purple flower with purple hypocotyl. Studies were also reported on cowpea and alfalfa.

The great differences in the behavior of citrus from other groups mentioned was discussed by Mr. Walter T. Swingle, who called attention especially to the large amount of variability occurring in the first generation hybrids. Many of these first-generation hybrids are of commercial value and may be propagated without variation from seeds which contain usually only false embryos originating from the nucellar tissues of the mother plant. In a few cases there is a true second generation.

Mr. L. C. Corbett and Mr. William Stuart took part in an informal discussion which followed the regular program.

H. L. Shantz,
Corresponding Secretary